Route-Flow Fusion: Integrated Routing and Traffic Analysis for Converged Services

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Discover, Resolve and Prevent the Hardest Problems in IP Networks

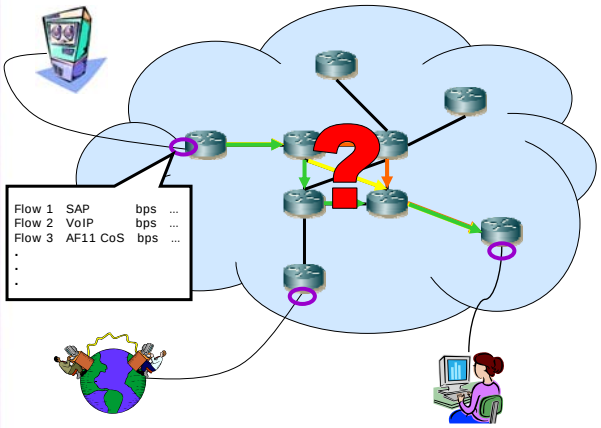
Packet Design, Inc.

"Harnessing the Intelligence of IP"

- Three years old, founded by Judy Estrin and Van Jacobson
- Pioneer and leader in Route Analytics for IP networks
- OEM supplier to hp/OpenView
- Cisco Technology Developer Partner
- Team of 50 with strong IP heritage based in Palo Alto, CA
- More than 180 production deployments worldwide

HP's Strategic Partnership with Packet Design Signals a Landmark in Network Troubleshooting

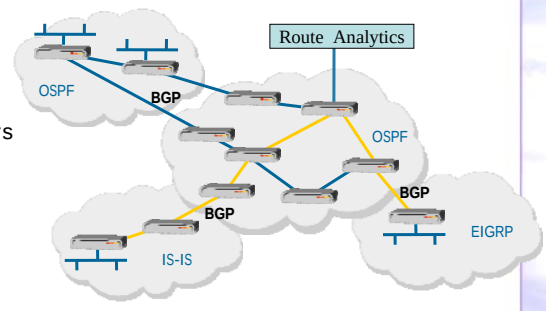
Limits of Traffic-Flow Analysis



- Traditional traffic analysis only provides per-interface views of traffic
- Impossible from one interface to know the path traffic takes through the network
- Only a fraction of interfaces are instrumented due to overhead
- Blind to network dynamics, core traffic patterns

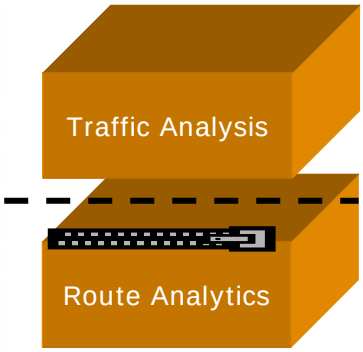
Route Analytics

- Listen passively to routing updates
- Create a real-time network map
  - As up to date as routers
- Analyse paths
  - Paths are computed using the same procedures as routers
- A historical view with breakdown of instability
  - Full routing event history/forensic audit trail
  - Flapping links, prefixes
  - Ability to look at state of routing at any point in recorded history



•Works across protocols (OSPF, IS-IS, BGP, EIGRP, RFC 2547bis)

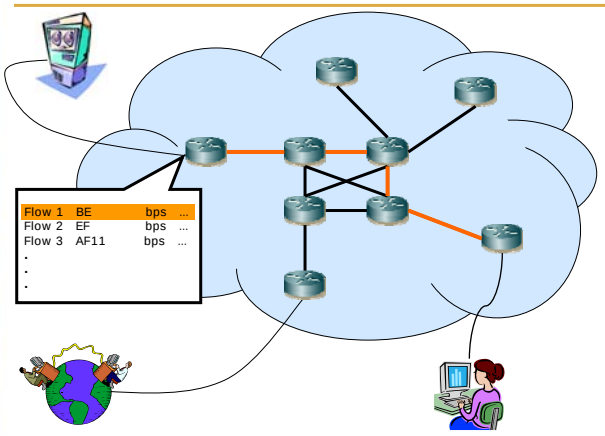
Route-Flow Fusion



Path-Aware Traffic Analysis

- Actual topology including ***real-time*** path changes
- Actual traffic flows across ***all links***; not subset of links
- Supports "what-if" ***modeling on "as running" network***
- Full ***historical data*** for forensic analysis
- Small footprint; minimal net load; ***highly scaleable***

How Route-Flow Fusion Works



- Collects flow data at key network locations
- Computes traffic flows across topology

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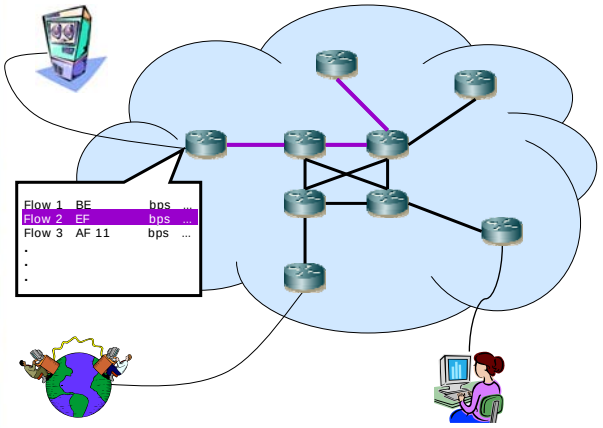

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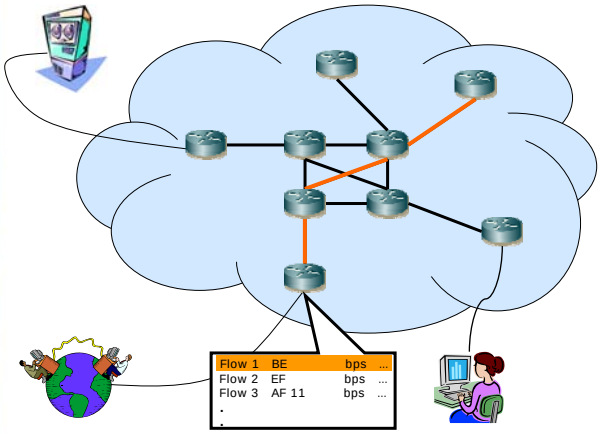

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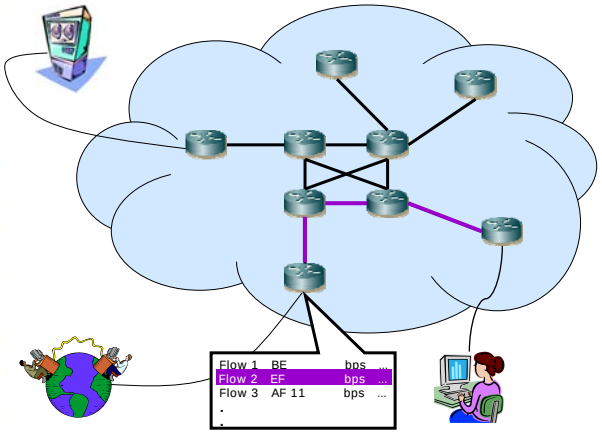

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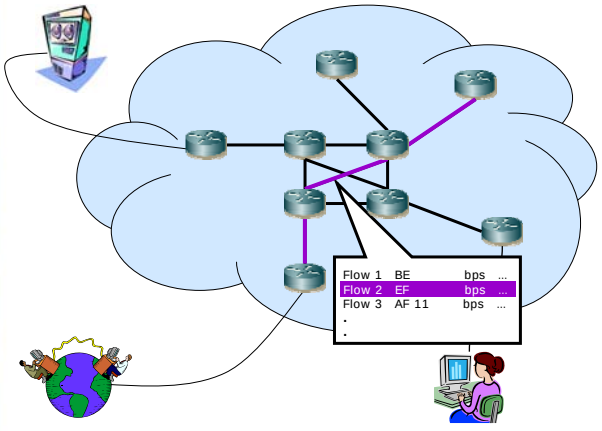
How Route-Flow Fusion Works



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- Computes traffic flows across topology
- Displays applications, CoS and utilization for ***every link***

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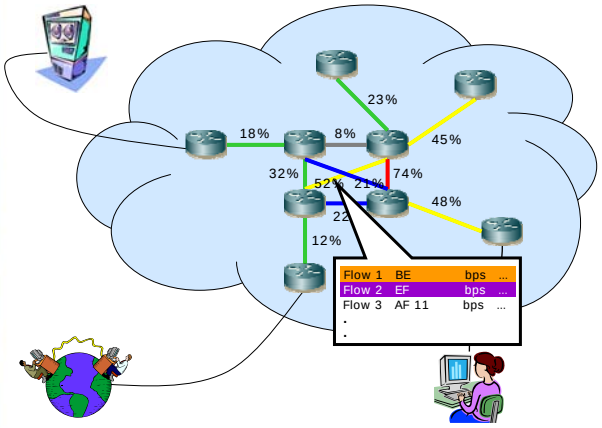
How Route-Flow Fusion Works



- Collects flow data at key network locations
- Computes traffic flows across topology
- Displays applications, CoS and utilization for ***every link***
- Stores complete traffic and routing history for analysis, diagnostics, and planning

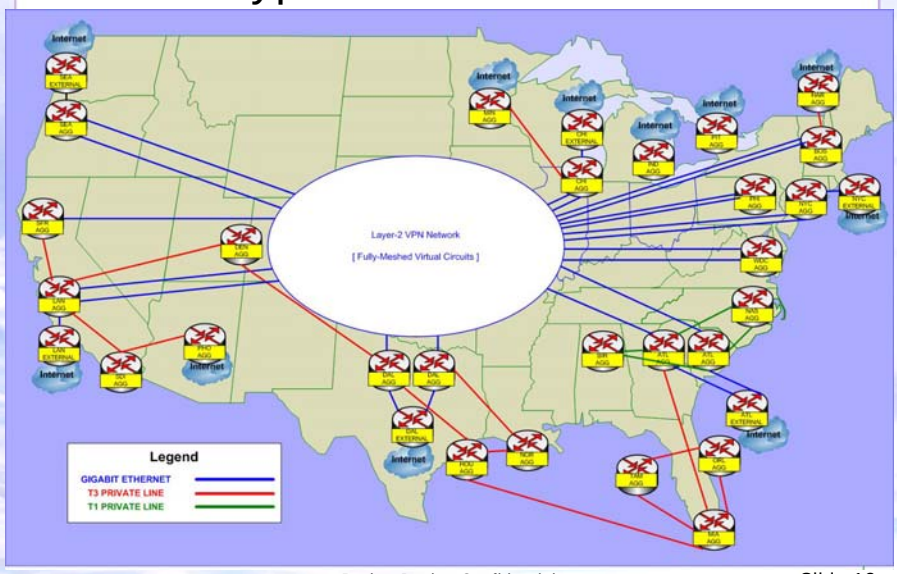
Cypress Communications

- Leading Managed Communications Provider:
  - Nation's largest in-building communications provider including 1,300 Cypress-powered office buildings
  - Serving over 6,500 customers and 650,000 handsets in 29 major metropolitan markets
  - Provides turnkey, state-of-the-art phone, voice, data and Internet solutions to mid-sized enterprises
  - Operates private network optimized for IP Telephony; only US company to deploy Nortel's MCS 5200 and CS 2000 at the core of its network
  - Highly skilled technical support and network operations center provide a superior customer experience nationwide
  - Continually ranked by Deloitte, year after year, as one of the fastest growing technology companies in North America

IP Transport Network

- National in scope with presence in 29 markets throughout the domestic United States
- Backbone: full-mesh of virtual circuits provided by layer-2 MPLS VPN service
  - VCs terminated on routers via redundant GE circuits
  - T3 circuits utilized in smaller markets
  - T3/T1 circuits utilized to connect shared tenant buildings and dedicated customers
- Multiple peering and/or IP transit points distributed throughout the domestic US
- Converged network platform: IP Telephony & Data
  - End-to-end QoS utilizing Differentiated Services model
- Data Centers in Atlanta and Dallas house IP Telephony components

Cypress IP Backbone



Routing/Traffic Analysis at Cypress

- Evaluated and Deployed at Cypress in 2006
- Immediately became effective tool for planning, engineering and traffic groups
- Deployment scenarios
  - OSPF metric tuning
  - BGP-4 policy tuning
  - QoS tuning
  - Capacity Planning
- Worked closely with Packet Design team to make route analytics technology effective for VoIP Service Management
- Two major advantages of route-flow fusion approach:
  - Full network visibility with limited Netflow collection required
  - Integrated understanding of routing and traffic—more real to life picture of actual network operation

Typical Use Cases

- Backbone monitoring, routing and topology design
- Network key statistics and baseline reporting
- Capacity Management/Planning
- Peering/IP Transit Arrangement Analysis

Backbone routing and traffic monitoring

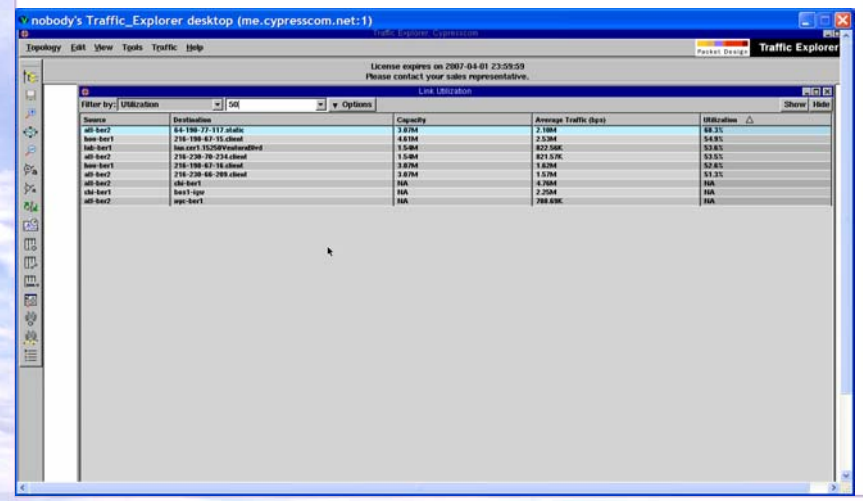
- Real-time visual display of backbone topology
- Visual display of network faults – link and router failure, maintenance activities
  - Before and after RIB comparison
- Zoom-in and pin-point exact event sequence for backbone outage
- What-if scenarios simulations for link-failure impact
- Routing design simulations for OSPF metric tuning

Network key statistics and baseline reporting

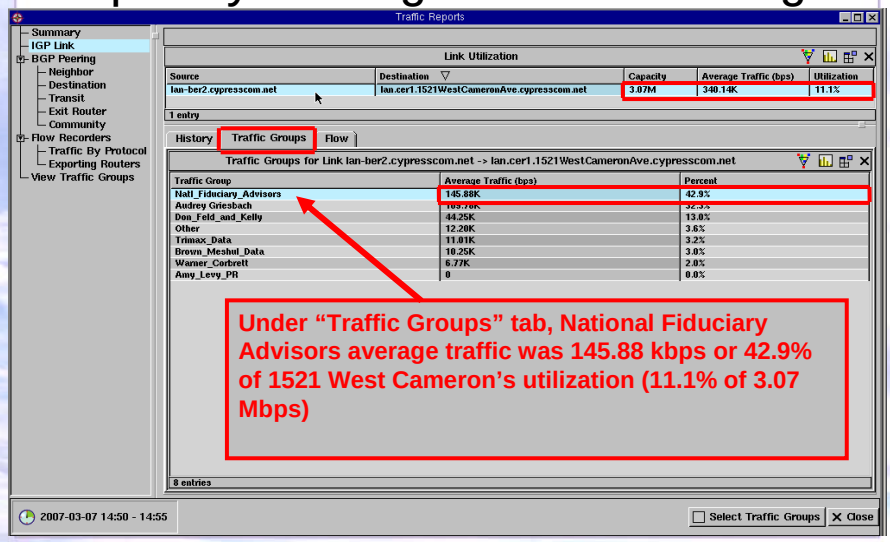
- Full picture of IP transport network control plane
  - Network size, availability and instability, trending
- Full picture of IP transport network data plane
  - Per-link per-CoS bandwidth utilization, trending
- Offers XML API to interface with route analytics data
- Collect network statistics programmatically
  - Network size as router count, link count
  - Network stability and availability analysis based on monthly backbone OSPF/BGP-4 events
    - Least stable links, maintenance impact, overall network availability statistics
- Generate list of key buildings based on BW utilization
- Used as a key component of network statistics reporting

Capacity Management/Planning

Link Utilization: filtered for > 40%



Capacity Management/Planning

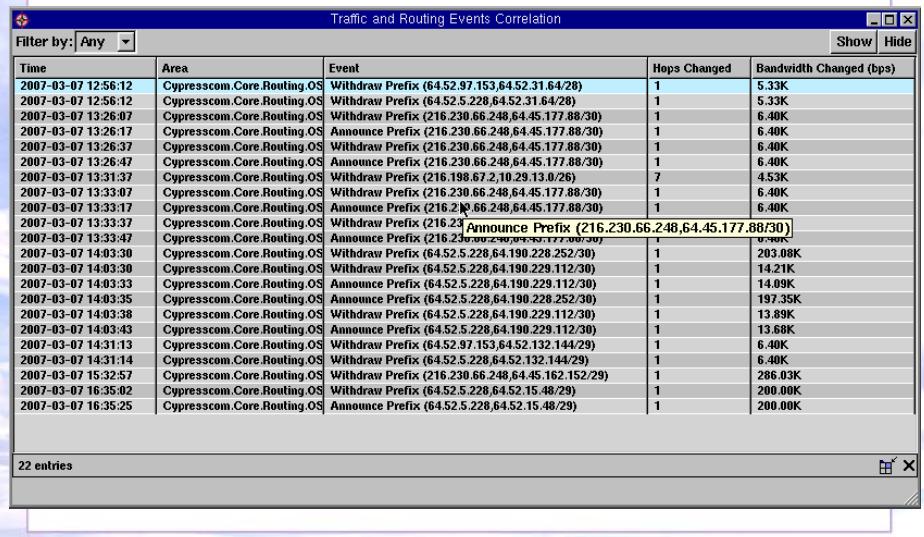


Under "Traffic Groups" tab, National Fiduciary Advisors average traffic was 145.88 kbps or 42.9% of 1521 West Cameron's utilization (11.1% of 3.07 Mbps)

Capacity Management/Planning

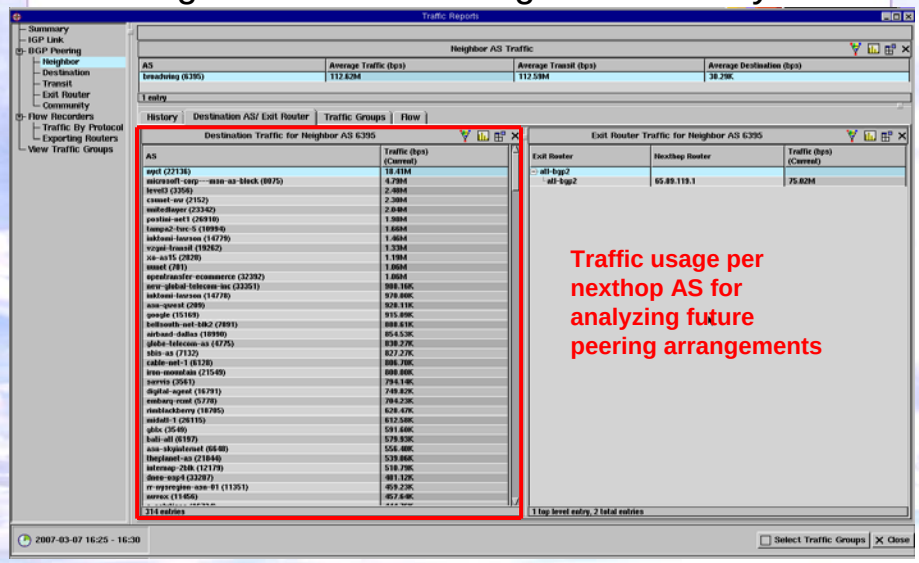
- Granular statistics on a per-customer basis
  - Ensure shared tenant customers are in-profile
  - Determine actual bandwidth utilization of VoIP bearer and signaling traffic
  - If a customer's bandwidth utilization is abnormal, can determine traffic type of increase; virus/worm?
- Can determine per-CoS utilization per-link
  - Ensure QoS is configured correctly
  - Can traffic-engineer on a per IP-prefix basis if needed

Correlate Routing's Impact on Traffic

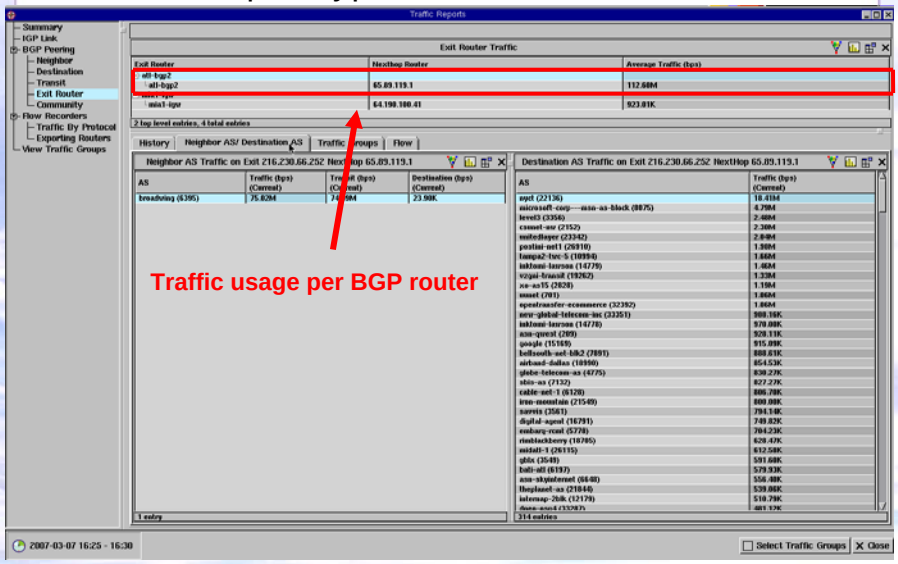


Time	Area	Event	Hops Changed	Bandwidth Changed (bps)
2007-03-07 12:56:12	Cypresscom.Core.Routing.OS	Withdraw Prefix (64.52.97.153,64.52.31.64/28)	1	5.33K
2007-03-07 12:56:12	Cypresscom.Core.Routing.OS	Withdraw Prefix (64.52.5.228,64.52.31.64/28)	1	5.33K
2007-03-07 13:26:07	Cypresscom.Core.Routing.OS	Withdraw Prefix (216.230.66.248,64.45.177.88/30)	1	6.40K
2007-03-07 13:26:17	Cypresscom.Core.Routing.OS	Announce Prefix (216.230.66.248,64.45.177.88/30)	1	6.40K
2007-03-07 13:26:37	Cypresscom.Core.Routing.OS	Withdraw Prefix (216.230.66.248,64.45.177.88/30)	1	6.40K
2007-03-07 13:26:47	Cypresscom.Core.Routing.OS	Announce Prefix (216.230.66.248,64.45.177.88/30)	1	6.40K
2007-03-07 13:31:37	Cypresscom.Core.Routing.OS	Withdraw Prefix (216.198.67.2,10.29.13.0/26)	7	4.53K
2007-03-07 13:33:07	Cypresscom.Core.Routing.OS	Withdraw Prefix (216.230.66.248,64.45.177.88/30)	1	6.40K
2007-03-07 13:33:17	Cypresscom.Core.Routing.OS	Announce Prefix (216.230.66.248,64.45.177.88/30)	1	6.40K
2007-03-07 13:33:37	Cypresscom.Core.Routing.OS	Withdraw Prefix (216.23		
2007-03-07 13:33:47	Cypresscom.Core.Routing.OS	Announce Prefix (216.23		
2007-03-07 14:03:30	Cypresscom.Core.Routing.OS	Withdraw Prefix (64.52.5.228,64.190.228.252/30)	1	203.08K
2007-03-07 14:03:30	Cypresscom.Core.Routing.OS	Withdraw Prefix (64.52.5.228,64.190.229.112/30)	1	14.21K
2007-03-07 14:03:33	Cypresscom.Core.Routing.OS	Announce Prefix (64.52.5.228,64.190.229.112/30)	1	14.09K
2007-03-07 14:03:35	Cypresscom.Core.Routing.OS	Announce Prefix (64.52.5.228,64.190.228.252/30)	1	197.35K
2007-03-07 14:03:38	Cypresscom.Core.Routing.OS	Withdraw Prefix (64.52.5.228,64.190.229.112/30)	1	13.89K
2007-03-07 14:03:43	Cypresscom.Core.Routing.OS	Announce Prefix (64.52.5.228,64.190.229.112/30)	1	13.68K
2007-03-07 14:31:13	Cypresscom.Core.Routing.OS	Withdraw Prefix (64.52.97.153,64.52.132.144/29)	1	6.40K
2007-03-07 14:31:14	Cypresscom.Core.Routing.OS	Withdraw Prefix (64.52.5.228,64.52.132.144/29)	1	6.40K
2007-03-07 15:32:57	Cypresscom.Core.Routing.OS	Withdraw Prefix (216.230.66.248,64.45.162.152/29)	1	286.03K
2007-03-07 16:35:02	Cypresscom.Core.Routing.OS	Withdraw Prefix (64.52.5.228,64.52.15.48/29)	1	200.00K
2007-03-07 16:35:25	Cypresscom.Core.Routing.OS	Announce Prefix (64.52.5.228,64.52.15.48/29)	1	200.00K

Peering/IP Transit Arrangement Analysis



Traffic Data per Cypress BGP router



Case Study: IP Telephony Performance Assurance

- Integrated routing and traffic analysis gives global context to monitor and prevent potential customer issues
- Provides visibility to precise path of customer traffic through whole network, and traffic volumes on relevant links
- Route-flow fusion technology showed a new IP prefix present from a relatively new customer, plus a large number of new IP flows on a certain set of links and paths
- The traffic engineering team was able to respond quickly and proactively to this organic growth in traffic
  - Modeled metric changes in network to shift certain aggregate flows to less used links
  - Averted any potential packet loss due to congestion

Conclusion

- Converged communications are critical to our customers business
- SPs need tools and visibility into both routing and traffic to increase their competitive edge, to improve customer satisfaction and to expedite troubleshooting
- SPs need both a real-time view, historic playback and full forensic detail of routing and traffic data
- SPs especially need view into core network's ability to deliver service quality, but can't collect Netflow everywhere
- Route-flow fusion technology provides a useful tool for monitoring and analyzing converged communication services